Graduate Student Training in Engineering: Instrumenting The Continental Shelf Wave Bottom Boundary Layer

Albert J. Williams 3rd
Department of Applied Ocean Physics and Engineering
Woods Hole Oceanographic Institution, MS#12
Woods Hole, MA 02543
phone: 508-289-2725 fax: 508-457-2194 email: awilliams@whoi.edu

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LONG-TERM GOALS

My long-term goals are to develop instruments to observe physical phenomena responsible for mixing the ocean, suspending and transporting sediment at the bottom, and entraining air and momentum at the surface under wind and waves.

OBJECTIVES

Education of students within the WHOI/MIT Joint Graduate Program in Oceanographic Engineering enables me to achieve these long term goals if I can train particular students in measurement and instrumentation. My objective in this effort is to train a student in making critical on measurements with these instruments to understand the presence of waves, heat and salt flux on the bottom boundary layer on the continental shelf.

APPROACH

At the start of this research program, Archie Todd Morrison III was completing his Ph.D. under my supervision on the development of the BASS Rake, a device based upon BASS, to measure the velocity profile with 1 mm vertical resolution in the bottom 10 cm of the water column in a wave environment. In May, 1997, Todd finished his thesis and the support was transferred to William J. Shaw who had been working on measurement of heat flux in the benthic boundary layer with BASS. Bill Shaw is completeing his Ph.D. under John Trowbridge's supervision on data acquired in CMO on our BASS tripod. Thus, two students have been supported under this project, each working on measurement of benthic mixing processes under waves.

WORK COMPLETED

Support under this grant permitted Bill Shaw to study heat flux and salinity flux under waves in the Coastal Mixing and Optics experiment. Bill had implemented a circuit to be added to BASS to obtain precise acoustic travel time measurements which was augmented in April 1997 with thermistors on the CMO BASS tripod so that speed of sound fluctuations could be compared with temperature fluctuation in the sensor volume to obtain salinity fluctuations.

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(Speed of sound, measured by the new circuit, is influenced by both temperature and salinity. By knowing the fluctuation in temperature as well as the fluctuation in speed of sound, one can determine fluctuation in salinity.) Data were recovered in the period April to August, 1997 from these measurements.

RESULTS

Bill Shaw has reported early measurements of temperature fluctuations (speed of sound fluctuations) from the circuit added to the CMO BASS instrument in an Oceans 96 IEEE/MTS paper. This preceded support under this grant. Additional work to separate the salinity part of the speed of sound fluctuations from the temperature fluctuations is proceeding but has not yet achieved results ready for reporting. The salinity fluctuations at the CMO site are small so the signal in this case is not strong; the speed of sound fluctuations can nearly all be accounted for by the fluctuations in temperature. While this result is null for salinity flux at the CMO site, it shows the sensitivity of the technique for estuarine mixing where salinity flux must be great.

IMPACT/APPLICATIONS

Salinity flux is a poorly understood process in estuaries; at least the physical processes responsible for mixing salinity are not well understood. Addition of a capability to measure salinity flux in the same volume as we presently measure momentum flux is a valuable addition to our toolkit.

TRANSITIONS

Salinity flux will routinely be measured on future BASS tripods in use in CMO, Hudmix, and future experiments in estuaries.

RELATED PROJECTS

Hudmix was a predecessor of the current AASERT. It was an NSF grant to study mixing of the Hudson estuary. It provided the initial support for Bill Shaw to add a circuit to BASS to measure absolute travel time and thus measure speed of sound fluctuations. The work was continued under this AASERT to add thermistors and permit salinity flux to be backed out of the speed of sound measurements. Since the salinity flux signal is small in the present experiment, it will be necessary to couple the salinity flux measurement with a yet-to-be funded estuarine study.

REFERENCES

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